Final Report

Autonomous Satellite Control
Through World Wide Web

for

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Autonomous Satellite Command and Control
Through World Wide Web

Scope of Project

The NASA Ames University Consortium's support of the Stanford Satellite Systems Development Laboratory's Autonomous Satellite Control Project has resulted in the development of a successful satellite control testbed. The overall goal of this project was to initiate the development of a hardware/software architecture in order to demonstrate command and control functions of amateur satellites through the World Wide Web. The basic infrastructure of such a system has been assembled and validated.

Principal Objective

The principal objectives that had been established to meet this goal included the following: determining the appropriate architecture and interfaces for the distributed system, adapt features of the Ames APA telescope control system, develop processing software on the ground and on the target spacecraft, and demonstrate the operational concept through use in the educational community.

Accomplishments

Each of these objectives has been met in one form or another. An initial architecture was adopted in September 1995 and has been evolved over time to suit the needs of the project. The form and approaches adopted in this architecture was influenced heavily by the Ames APA system. Processing software was developed for the central system's server, the ground stations, and the target spacecraft. Initial plans called for integration of the currently operational WeberSat spacecraft. While this work occurred, the integration of this project with Weber State's activities (performed through a separate contract) was marginal. Integration of the WeberSat spacecraft is still occurring, but the pace of this work is slower than originally anticipated. To surmount this problem, SSDL expanded its work and initiated the integration of its own microsatellite, SAPPHIRE, into the WebSat system. SAPPHIRE is a fully operation satellite that is currently in an SSDL laboratory undergoing final system checkout. This provided an excellent opportunity to directly control the development of the end-to-end software integration.

To complete the activities of this grant, the WebSat system was used to demonstrate semi-autonomous commanding for an experiment on the SAPPHIRE satellite. In a public demonstration, an audience member supplied a phrase for SAPPHIRE to broadcast via its voice synthesizer. This phrase was entered into the appropriate Web page. The WebSat system accepted this input, generated the necessary spacecraft command, and sent this command to the SSDL ground station. Due to FCC guidelines, a human operator took this command and entered it into the ground station's transmission software (this was done using the exact command syntax generated by the WebSat

system). The command was transmitted to SAPPHIRE, processed, and executed. The result was a radio broadcast of the phrase which was received by a scanner located in the seminar room where the audience was located. This culminated in the first public demonstration of Web based, semi-automated commanding through the WebSat system.

Results of this Collaboration

The results of this collaboration has lead to fund from the Jet Propulsion Laboratory New Millennium Program funding to continue this research by two Stanford University Aeronautics and Astronautics students work on Ph.D. related thesis topics.

Additionally, this work at Stanford has prompted JPL to fund a graduate student study of the NASA Deep Space Network to evaluate possible system architectures for the year 2010.